User guide

for team 'Konti' solution of PLC+ challenge task

TEAM KONTI

1. Opening screen

When you start your HMI session with loaded ‘Team Konti's project’, an opening screen (*fig 1.0*) should appear. On the opening screen,there are *Login* button (*fig 1.1*) and *About* button (*fig 1.2*). When you click the *Login* button, login screen should appear (fig 1.3). To enter the Main screen, you need to have an authorization confirmed by entering both username and password.

Initial username and password are by default set to :

Username -> *Administrator*

Password-> *111111*

***Disclaimer**: It is highly advised that you change both username and password after first usage.*

When you click the *About* button, *short explanation of the problem* popup screen (figure 1.4) should appear.

figure 1.0- Opening screen

figure 1.1- Login button

figure 1.2-About button

figure 1.3- Login screen

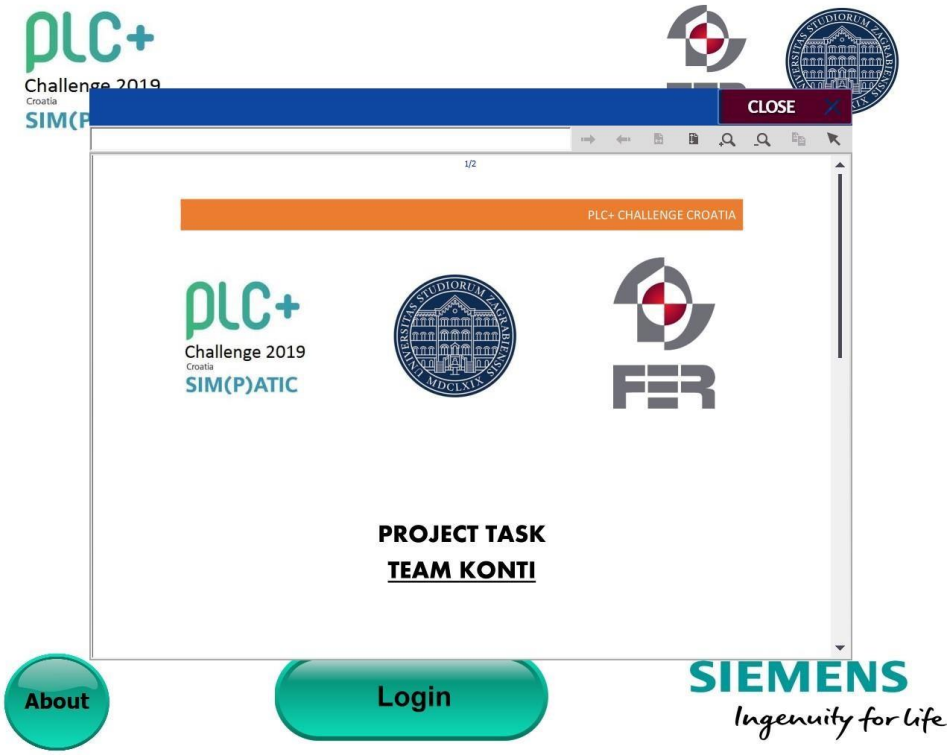

figure 1.4- short explanation of the problem popup screen

2. Main screen

Main screen is used for control of crane behaviour and for container movement, depending of the mode of work. Current mode of work is shown by color of icon next to button for changing modes, where dark pink color shows which of four modes is currently active.

Modes of work are by order:

- *Automatic* mode- crane movement is optimised for minimal number of manipulations and time elapsed. Operator does not have direct control of crane movement nor the possibility to choose the next container for movement. Order of operations is chosen only by PLC using algorithm made by Team Konti.

- *Semi automatic* mode - crane movement is optimised for minimal number of manipulations and time elapsed. Operator has to allow the next movement of crane, but does not have the possibility to choose the next container for movement, nor change the next movement of crane. Order of operations is chosen only by PLC using algorithm made by Team Konti.

- *Manual* mode - crane movement and the next container for movement is controlled and chosen directly by an operator. This mode of work carries some limitations and risks, so it is not advised to be used if needed precautions and education are not carried out.

- *Stop* mode - by choosing *Stop* mode (not to confuse with *Emergency stop* mode, see distinction lower in text), all of modes mentioned above execute current operation, and program comes to a halt. *Stop* mode is used when *Load next ship* operation is performed and etc. .

  More detailed information about all of modes mentioned above is located on pages regarding to all of modes each lower in the text.

When in one of modes and after the reinitialization of Data Blocks with the ship in bay (see example case lower in text) screen always has these parts:

- *'Current user'* notification and *'Logout'* button (top right corner) – it notifies us which user is logged in and allow us to logout

- *All ID'S* button- It allow us to see current state of all bays not only in crane view mode, but to see all IDs of containers in all bays.

- *Disbalance sliders* (located under the ship containers)- they are used to show disbalance of the current ship

- *Current 'Crane position'* (located in left part of screen, under Bay 1 containers) – it notifies us what is current crane position

- Current 'Crane position' (purple rectangle with transparent middle, located on top of container depending on the current location)- it notifies us what is current crane position

- *Alarm window* (located in bottom of screen) – current alarms show up on this screen (list of all alarms and alarm explanations is located lower in the document)

- *'Elapsed time' and 'Current number of manipulations'* (located in left part of screen, under Bay 1 containers) – they are used to notify us about elapsed time of crane movement and current number of manipulations made by crane

- 'Emergency stop' button (located in bottom right corner)- it is used when emergency stop is needed. It changes current PLC mode from 'RUN' mode to 'STOP' mode and it immediately stops any current operation

- 'Reinitialize' button (located in bottom left of the main screen)- It is used to reinitialize all memory and outputs of PLC to initial state

- *'Stop mode'*, *'Manual mode'*, *'Semi-auto'* and '*Automatic*' buttons (located in upper right part of screen)- they are used to choose wanted mode of work

- *'Current ship'* and *'Load next ship'* button- used for loading next ship into bay and notifying us about current ship number

In ***Automatic mode*** (figure 2.1) crane movement is optimised for minimal number of manipulations and time elapsed. Operator does not have direct control of crane movement nor the possibility to choose the next container for movement. Order of operations is chosen only by PLC using algorithm made by Team Konti. Input arguments are data blocks (DB-s) that need to be placed in PLC program and need to be named as: 'From_Bay0_to_Bay12[**DB20**]- list of containers that need to be moved from ship to bay, and 'From_Bay12_to_Bay0'[**DB21**]-list of containers that need to be moved from bay to ship. If execution of program is not possible (not enough free space on ship, not enough free space on bay 1 or bay 2, etc.) appropriate alarm will pop up. List of alarms is available lower in the document.

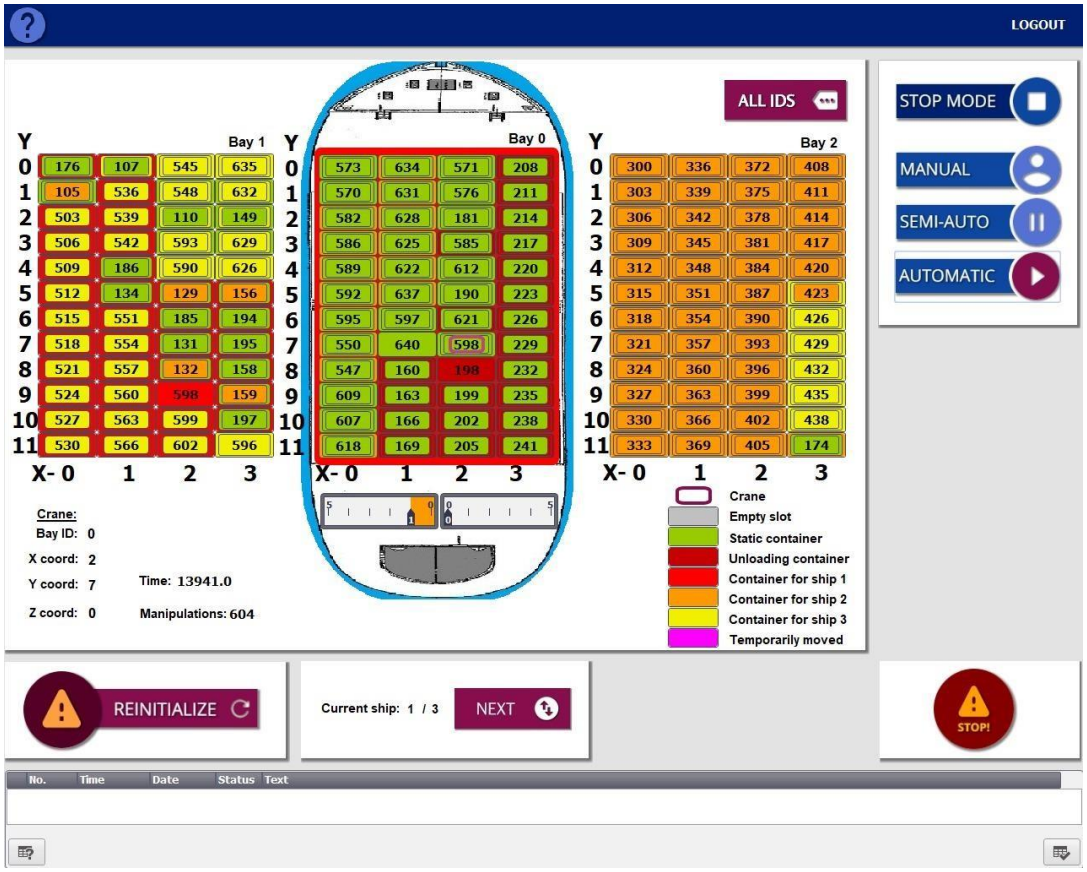

figure 2.1- Automatic mode of work

.

- In ***Semi-automatic mode***, crane movement is optimised for minimal number of manipulations and time elapsed. Operator has to allow the next movement of crane, but does not have possibility to choose the next container for movement, nor change the next movement of crane. Order of operations is chosen only by PLC using algorithm made by Team Konti. Completion and execution of next step is triggered by the click of '*Execute*' button as shown in figure (2.2). Algorithm of semi-automatic mode is same as automatic mode, but is used when an operator needs to watch every step individually. As shown on example picture, we can see that next operations are going to be relocations from *Bay 0, X position- 1, Y position- 4 , Z-1 and Z-2,* because as shown on *Semiauto mode* tab (located in lower right part of screen), we need to move container from lowest position (*Z=3*), and we have containers above. Locations for relocations of containers above are shown on *Pending relocation destinations* (located in lower middle part of screen).

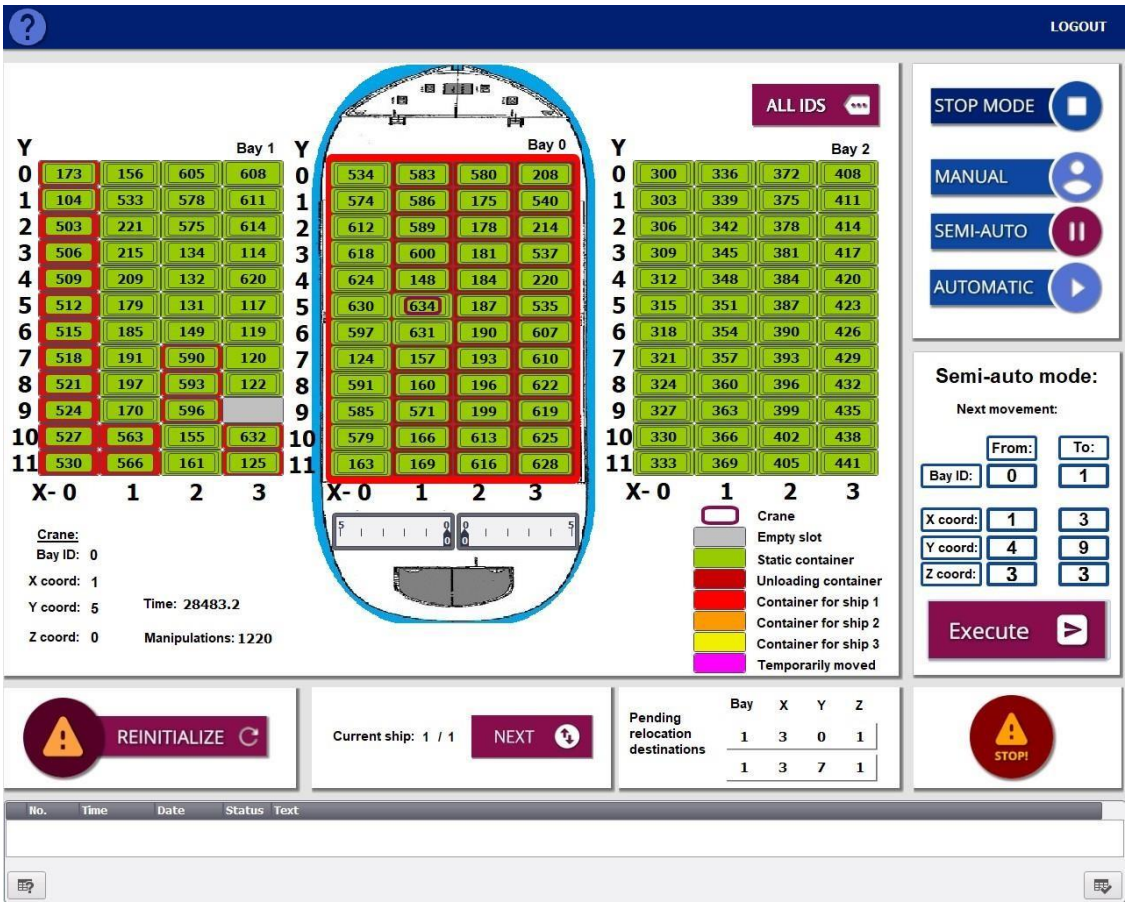

figure 2.2- Semi automatic mode

In ***Manual mode***, there are two possibilities of choosing a container to be moved:

- 1. By container ID
- 2. by container coordinates

When choosing the location of container to be moved, an operator needs to watch on four things :

1. That container with the given ID or at given coordinates exists
2. That the location where the container is going to be moved is empty
3. That there are no containers above the container that is going to be moved
4. There are containers under the location the location where the container is going to be moved

If the operator does not watch on these 4.conditions, an corresponding alarm will occur(see alarm table lower in the text).

It is important that after every entry of value into I/O fields, operator needs to click enter to enter and confirm value.

figure 2.3 – Manual mode

In ***Stop mode*** (figure 2.5), any of the 3 modes mentioned earlier (***Automatic mode, Semi-automatic*** and ***Manual mode***) comes to a halt, and by entering into it, last movement is performed and then the crane waits for the next instruction. Not to confuse with '***Emergency stop***' button, where both PLC and crane go to the stop mode, with that reinitialising all memory and outputs to initial state. *Stop* mode is used when *Load next ship* operation is performed, and it is highly advised that before changing current mode, an operator first changes mode to *Stop* mode, and then changes to wanted mode.

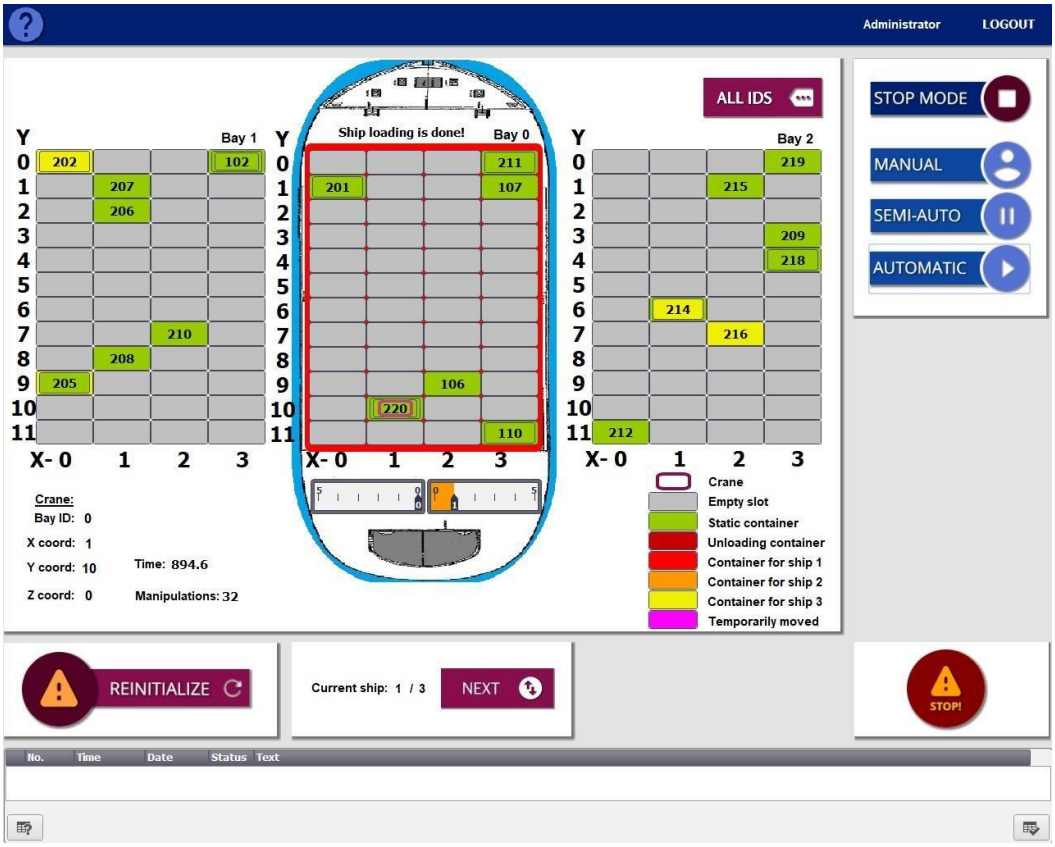

figure 2.5 -Stop mode

Alarm table

List of all possible alarms and explanation of the alarms is given in *table 1.0* . If any of the alarms occurs in the mode that is not assumed, contact customer support or manufacturers of the used software.

Alarm name	***Explanation of alarm***
Not enough space on ship!	*This alarm is triggered if you are trying to load a container to the ship but there is no space left. Please unload a container from the ship first in order to free some space on the ship.* *This alarm is also triggered if your automatic loading/unloading lists would result in a ship being overloaded and thereforee disables the automatic algorithm.*
Unable to complete: ship would not remain balanced!	*This alarm is triggered when the next requested/calculated action would result in the imbalance of the ship, which is not allowed. If this happened in manual mode please check your "to" and "from" locations and check the ship's balance. If this occurs in the automatic mode, please contact engineers for assistance.*
Some containers on loading lists/manual mode do not exist!	*This alarm is triggered if one or more containers from loading/unloading lists does not exist in a specified bay.* *IMPORTANT: Please do not start automatic mode if you get this alarm or unexpected behavior could occur. The algorithm will most likely just ignore the nonexisting IDs, but this is not recommended.* *This alarm is also triggered if you enter a container id in manual mode and the*

	container can't be found in bay nor on the ship.
The "FROM" slot is empty!	*This alarm is triggered if you are trying to pick up a container from an empty slot in manual mode. Please try picking up another container. If this happens in automatic mode, please contact the engineers for assistance.*
Not enough space in the bay!	*This alarm is triggered if you are trying to unload a container from the ship and both Bay 1 and Bay 2 are full. Please try moving a container from Bay 1 or Bay 2 to free some space.* *This alarm is also triggered if your automatic loading/unloading lists would result in both bays being overloaded and therefore disables the automatic algorithm.*
Requested coordinates do not exist!	*This alarm triggers if you enter the coordinates outside of an acceptable range in auto mode.* *Please check that your coordinates are within following limits:* To/from "X": ***0-3*** To/from "Y": ***0-11*** To/from "BAY": ***0-2***
The "TO" slot is already occupied!	*This alarm is triggered if you are trying to move a container to a slot that is already occupied in manual mode. Please try moving a container to another slot. If this alarm triggers in automatic mode, please contact the engineers for assistance.*

There are no more ships to load today!	*This alarm is raised when you try to load a next ship and there are none left. If you think you shouldn't be seeing this alarm at this time, please contact the programmers for assistance.*
No conts bellow destination coordinates. Can't drop in midair!	*This alarm is rised when you are trying to put the container down at the position where there are no containers bellow it and it's not the lowest position. Doing this would result in the container being dropped in mid-air and that is not allowed. Please check your manual coordinates and try again.* *If this happens in automatic mode, please contact the algorithm creators for assistance.*
There are conts on top of the origin coordinates!	*This alarm is rised when you are trying to pick up a container that has other containers on top of it. You must first move those containers elsewhere and then try again.* *If this occurs in automatic mode, please contact algorithm creators for assistance.*
There is no ship in bay0 at this time!	*This alarm is rised when you try to perform any action (starting AUTO mode, moving containers to/from ship, etc) involving a ship (Bay0) and one isn't present in the bay. Please load a ship first and then try again.* *If this occurs in automatic mode, please contact algorithm creators for assistance.*
Unable to change ship! Please switch to STOP mode first!	*You can only load next ship while in "STOP" mode for safety and reliability purposes. Please change to stop mode first and then proceed loading the next ship.*

Table 1.0- List of all possible alarms

Example project

Disclaimer**: time elapsed and number of manipulations in this example can be equal or bigger than in real simulations. The code can be subjected to minor optimisations and last version of code can be different than the version for which this example project was made*. ***This example project was tested in v 2.0

At this part of manual, we are going to show basic steps to successfully unload/load ships and show how to use Team Kontis project solution in a good way, with that minimising the probability of malfunctioning and unexpected behaviour.

First step is to load example Data blocks in program. Example blocks that need to be located in program are:

'From_Bay0_to_Bay12[**DB20**] - list of containers that need to be moved from ship to bay.

'From_Bay12_to_Bay0'[**DB21**] - list of containers that need to be moved from bay to ship.

'Current_state_of_Bay_0[**DB10**] - list of containers that are located in Ship 1, Ship 2 and Ship 3 [Bay0] accordingly

'Current_state_of_Bay12[**DB11**] – list of containers that are located in Bay 1 and Bay 2, accordingly

After compilation of the program, download program to PLC. Start the HMI simulation and if there are no problems, *Login* screen (*fig 3.0*) should appear. After login, *Main* screen should appear (*fig 3.1*). At this point, it is highly advisable to click '*Reinitialize*' button located in bottom left corner, and by doing that reinitialize all the outputs and memory blocks in the PLC.

figure 3.0- Login screen

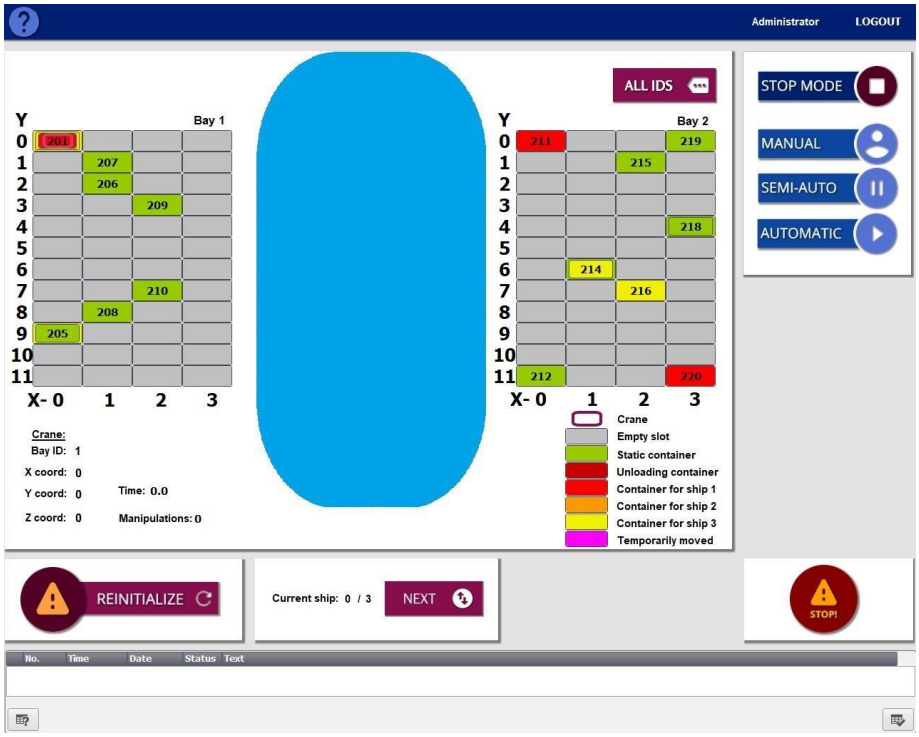

figure 3.1- Main screen after clicking 'Reinitialize' button

By clicking the '*ALL ID'S*' button located in the upper middle of the screen, popup screen pops up (*figure 3.2*), showing current state of all bays.

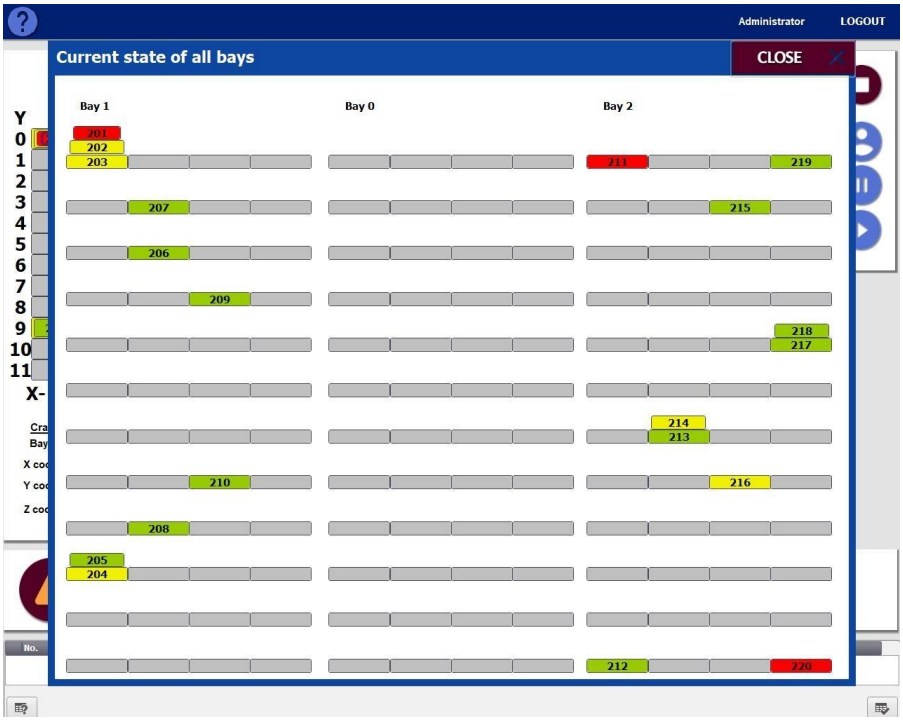

figure 3.2 – 'Current state of all bays' popup screen

Click the '*close'* button on popup screen to close the popup screen, and after that click *Next* button (located under bay 0) to move the next ship into harbour. After the ship has entered the harbour, screen should look like this (*figure 3.3*). Current mode needs to be *'Stop mode* before clicking *'Next button'.*

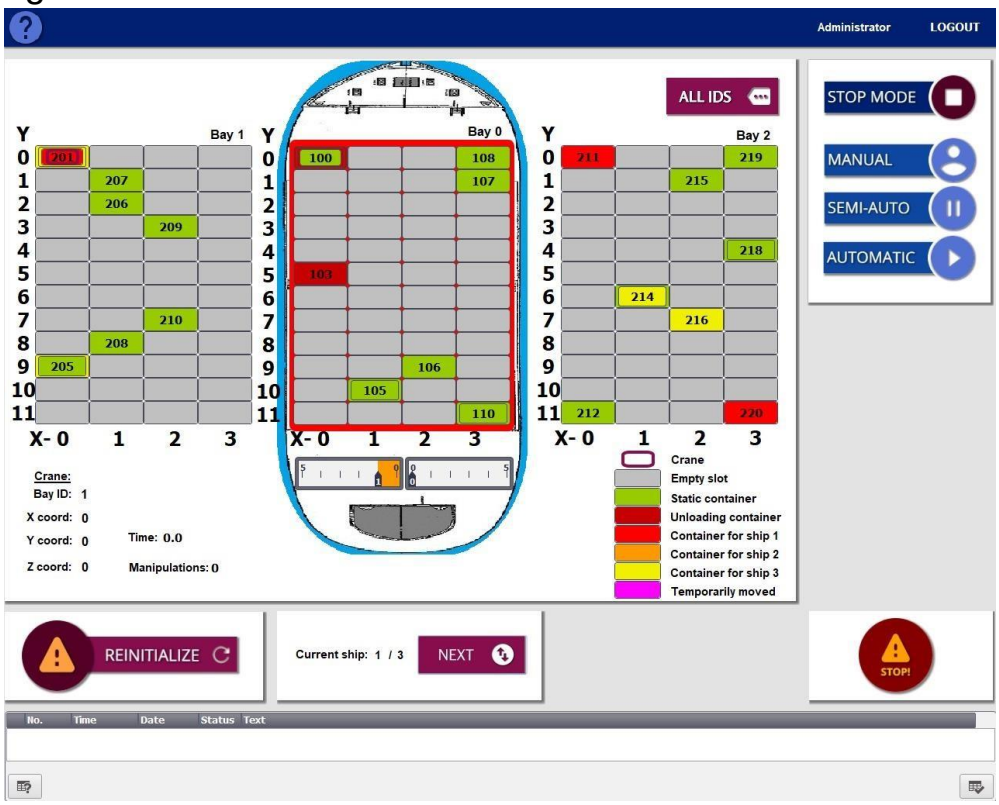

figure 3.3 – main screen after moving the ship into harbour

Change the current mode of work to '*Manual mode'*(*fig. 3.4*) (by clicking the *'Manual'* button) and enter number ID 209 into *'Find by ID*' input field located in the '*Manual mode:*' tab. After that, click enter to acknowledge the ID. Screen should look like this: (*fig. 3.5*). *Find by ID* input field becomes 0, and *From I/O fields* are loaded with the location of container with the ID 209. Enter coordinates to *TO* fields located in the '*Manual mode*' tab accordingly : *Bay ID 2, X coord: 3, Y coord 3, Z coord 3.* ***It is important that after every of every value into I/O fields, operator needs to click enter to confirm and acknowledge value.*** After clicking *'Execute'* button located in the '*Manual mode*' tab, container with ID 209 should be moved to wanted location (*fig 3.6*).

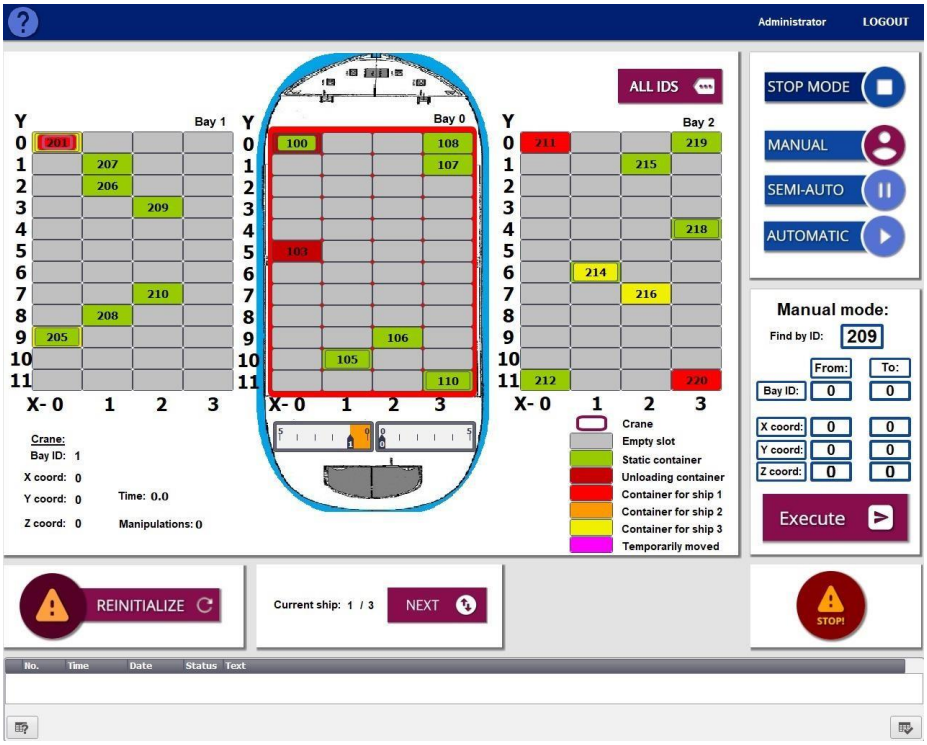

figure 3.4- Manual mode before clicking enter for searching by ID

figure 3.5 Manual before clicking 'Execute' button

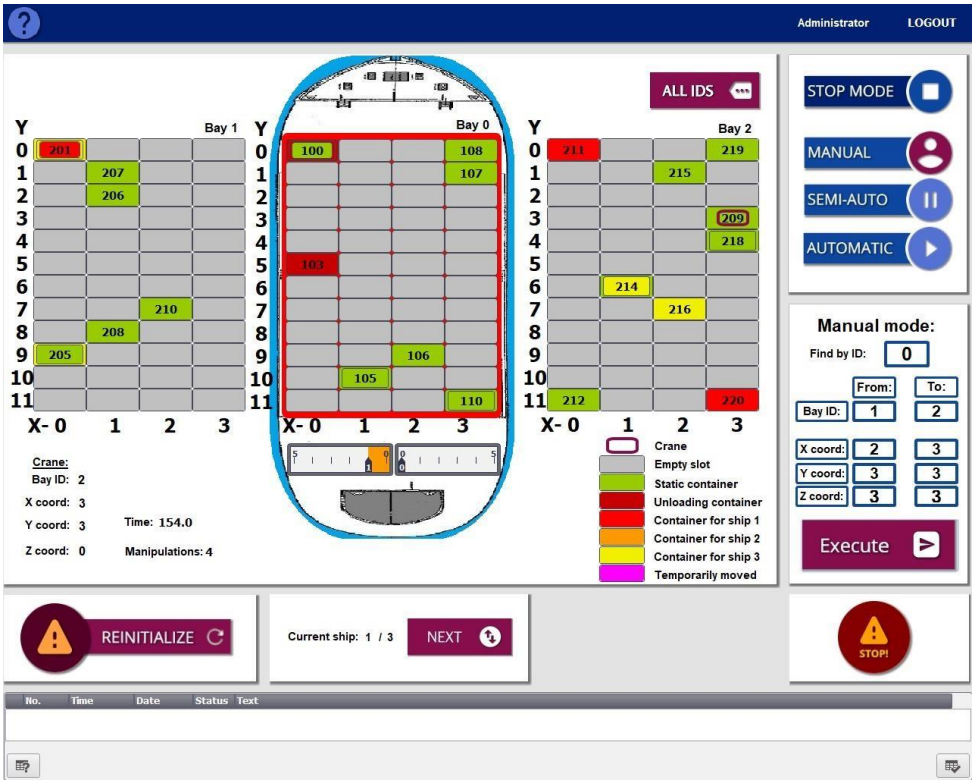

figure 3.6 Manual mode after moving container with ID 209

This was the example for *Manual mode*. Click on the '*Semi-auto*' button to change the current mode to '*Semi-auto*' mode. After clicking the button, mode should change (*fig 3.7*).

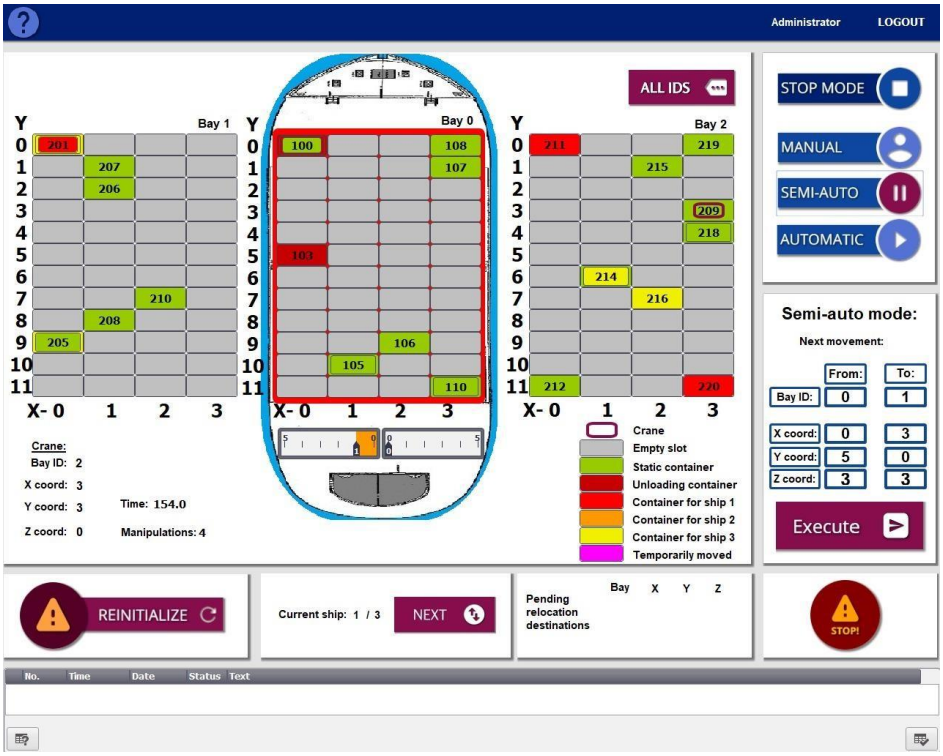

figure 3.7 – Semi automatic mode

Click '*Execute*' button and the container that was chosen by the algorithm to be the most optimal should be moved to the location that was shown to be the most optimal (*fig 3.8*).

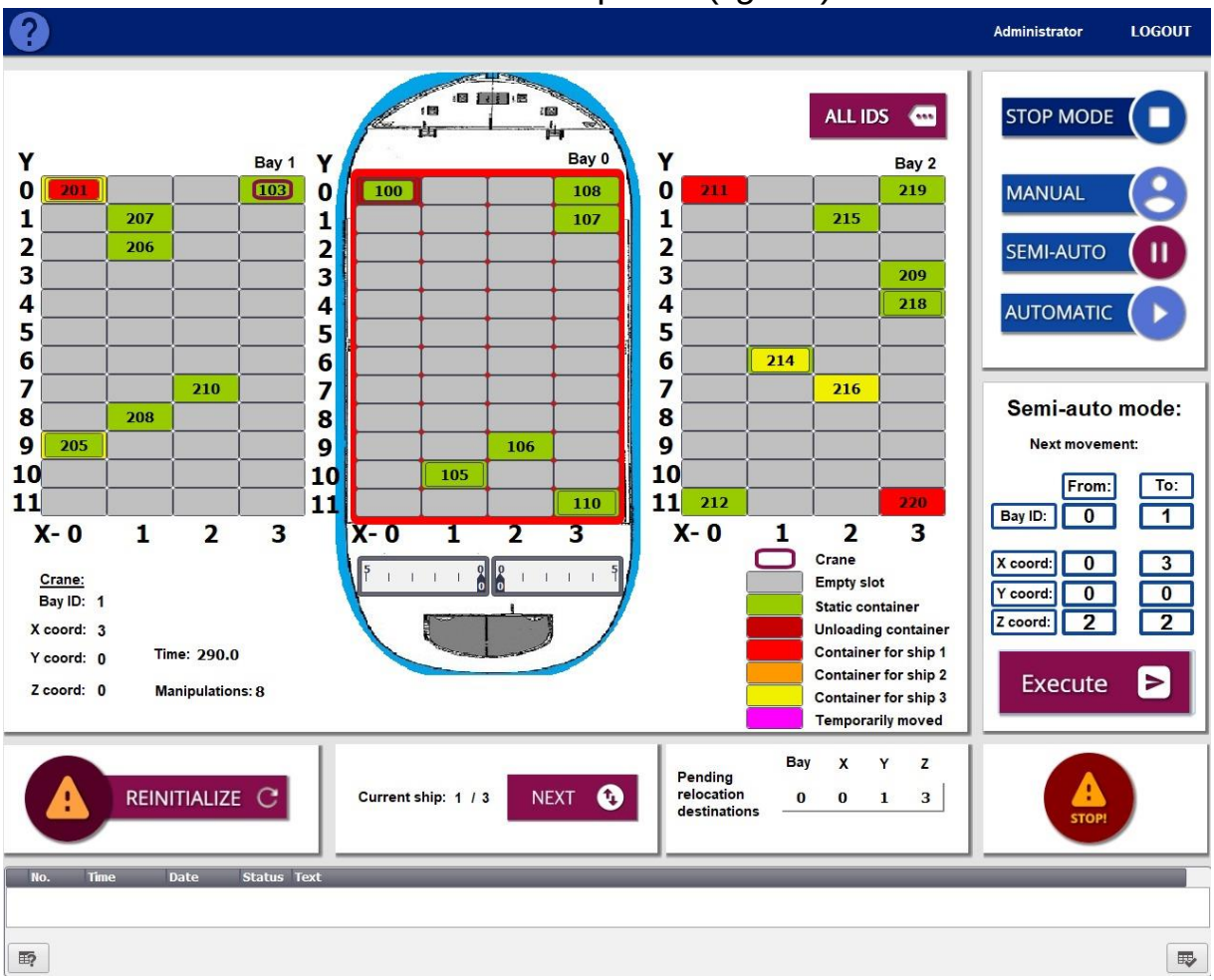

figure 3.8.-Semi auto mode, container was moved

As we can see on *figure 3.8*, next container to be moved has other container above (*Pending relocation destinatio*n exists), so the next operation that must be done is to move the container above to optimal location. In this moment, we are going to change the current mode to '*Stop*' mode, and then switch to '*Automatic*' mode. As we can see on *figure 3.9,* '*automatic*' mode has relocated all containers that needed to be relocated, and we can see on top of the ship that text '*Ship loading is done!*' is displayed. The procedure for moving the next ship is following:

1. Put the program into '*Stop* mode.

2.Click the '*Next*' button to load next ship

3. Click the '*Automatic*' button to change the current mode from '*Stop*' mode to '*Automatic*' mode.

When the containers that are needed to be loaded are loaded and when the containers that are needed to be unloaded are unloaded, again we can see on top of the ship that text '*Ship loading is done!*' is displayed.

Figures 3.9, 4.0,4.1,4.2 and 4.3 show the states of other ships after *automatic* loading and unloading is performed

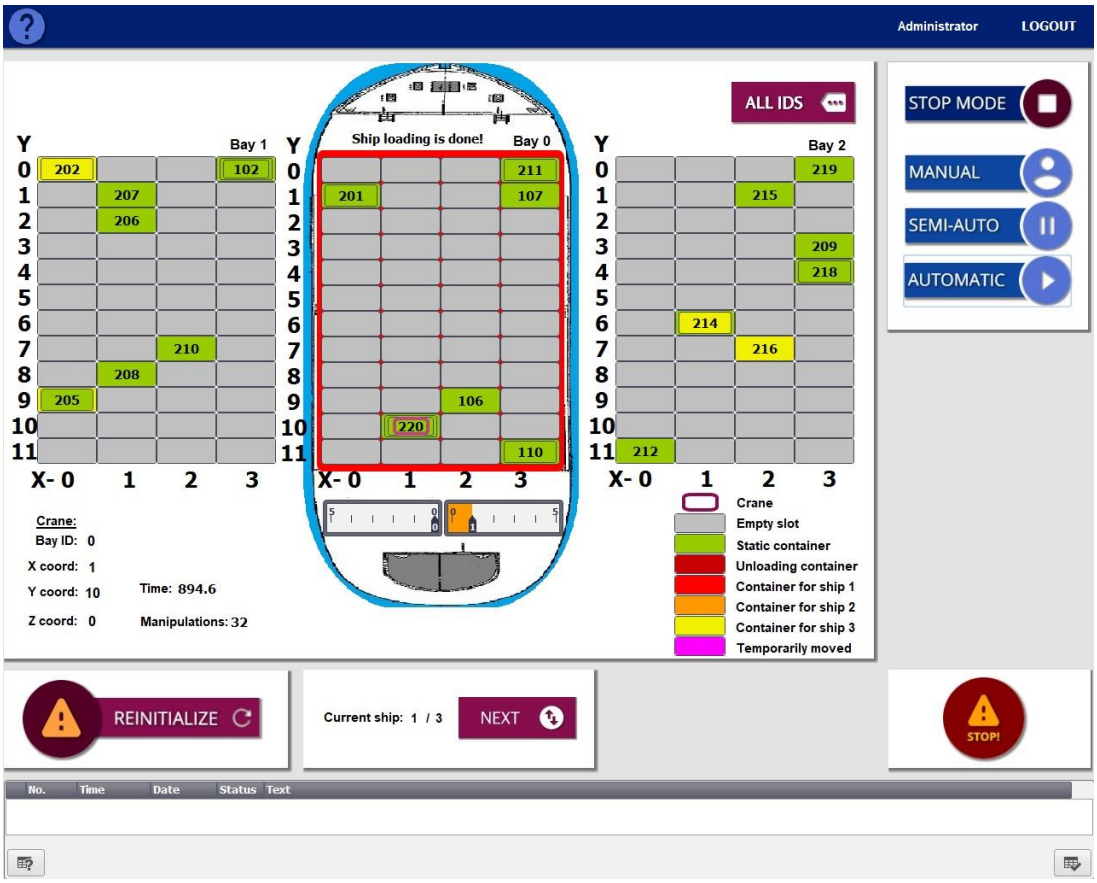

figure 3.9.-Automatic mode, Ship 1 is loaded/unloaded

States of ship 2 and harbour before and after loading/unloading

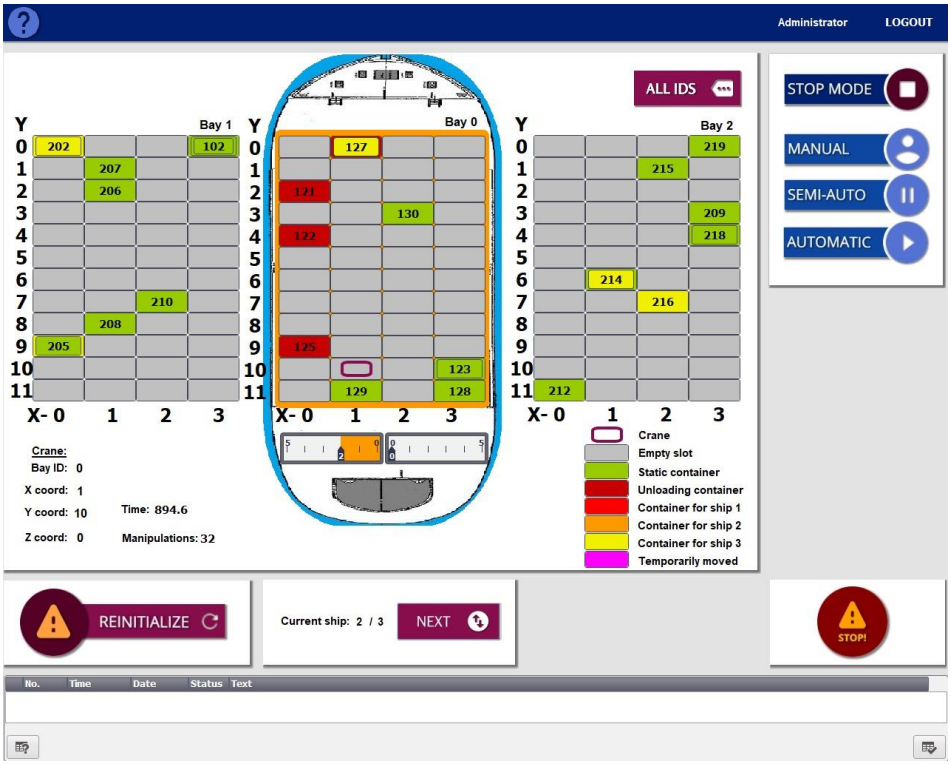

figure 4.0.-Automatic mode, Ship 2 and harbour before unloading/loading

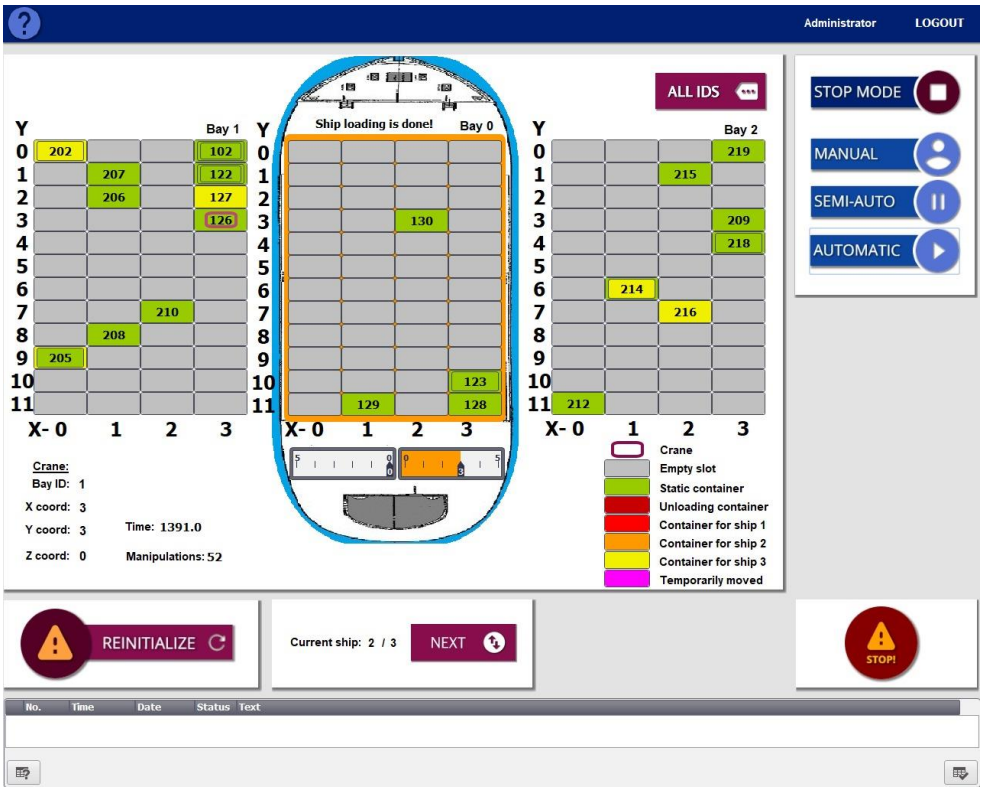

figure 4.1.-Automatic mode, Ship 2 and harbour after unloading/loading

States of ship 3 and harbour before and after loading/unloading

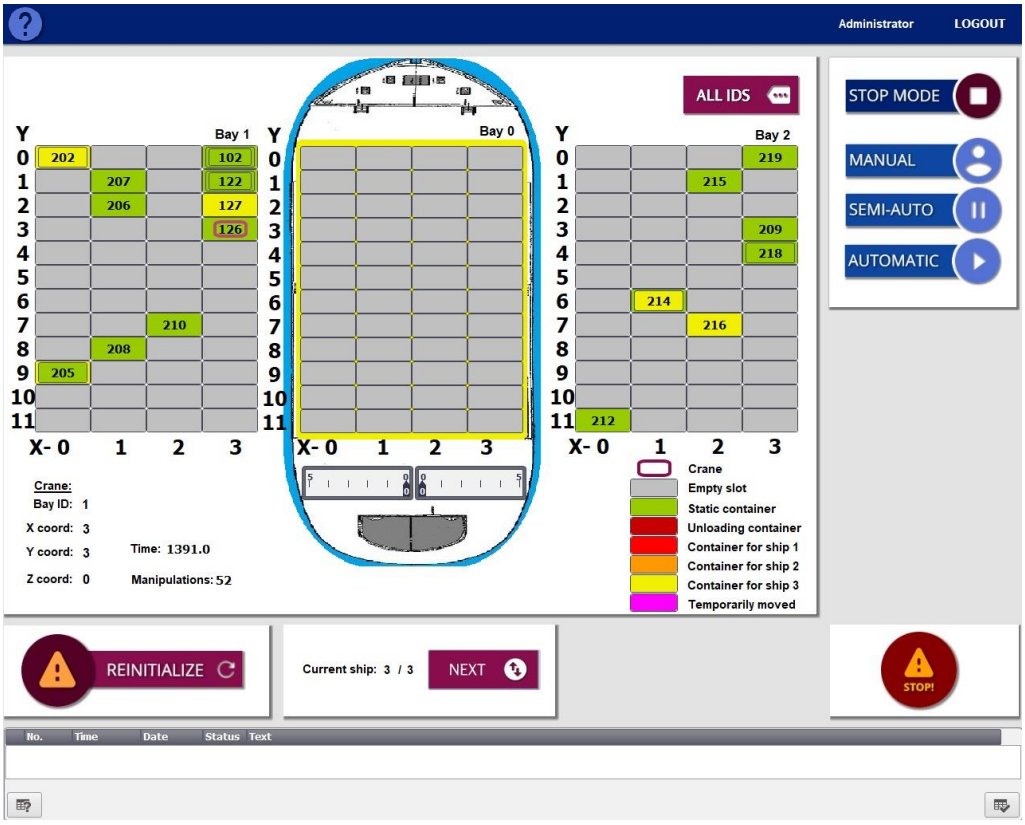

figure 4.2.-Automatic mode, Ship 3 and harbour before unloading/loading

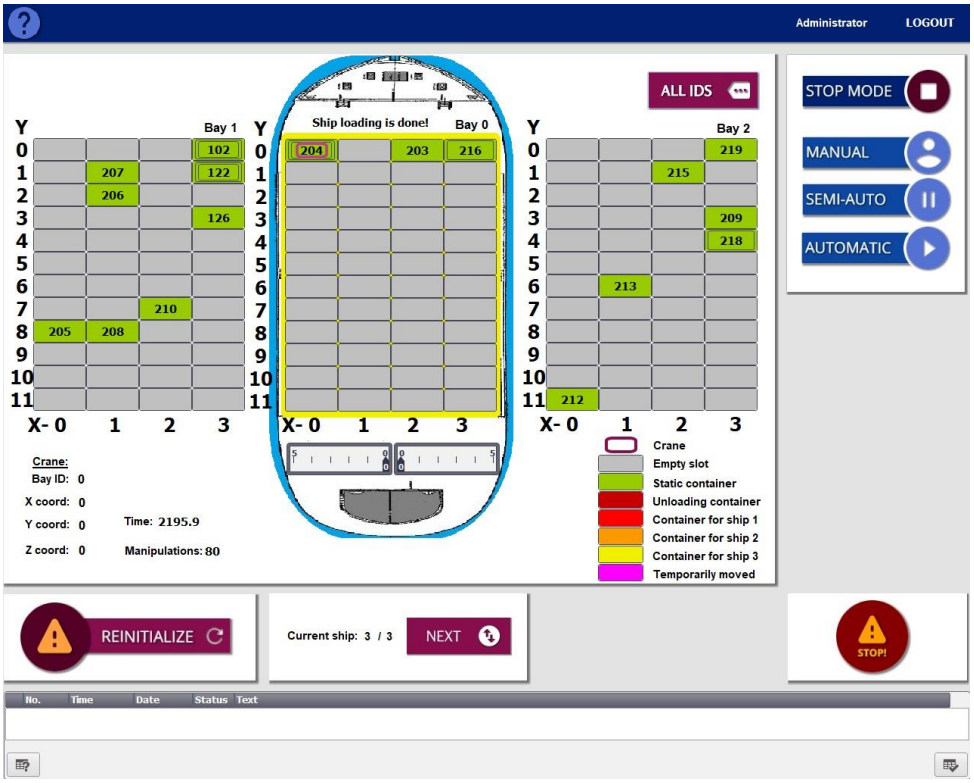

figure 4.3.-Automatic mode, Ship 3 and harbour after unloading/loading

And at the end of this example, we are going to show Current state of all bays by clicking *'ALL ID'S'* button(*fig 4.4*) . We can see that there are no container for loading/unloading both on ship and on bay 1 and bay 2.

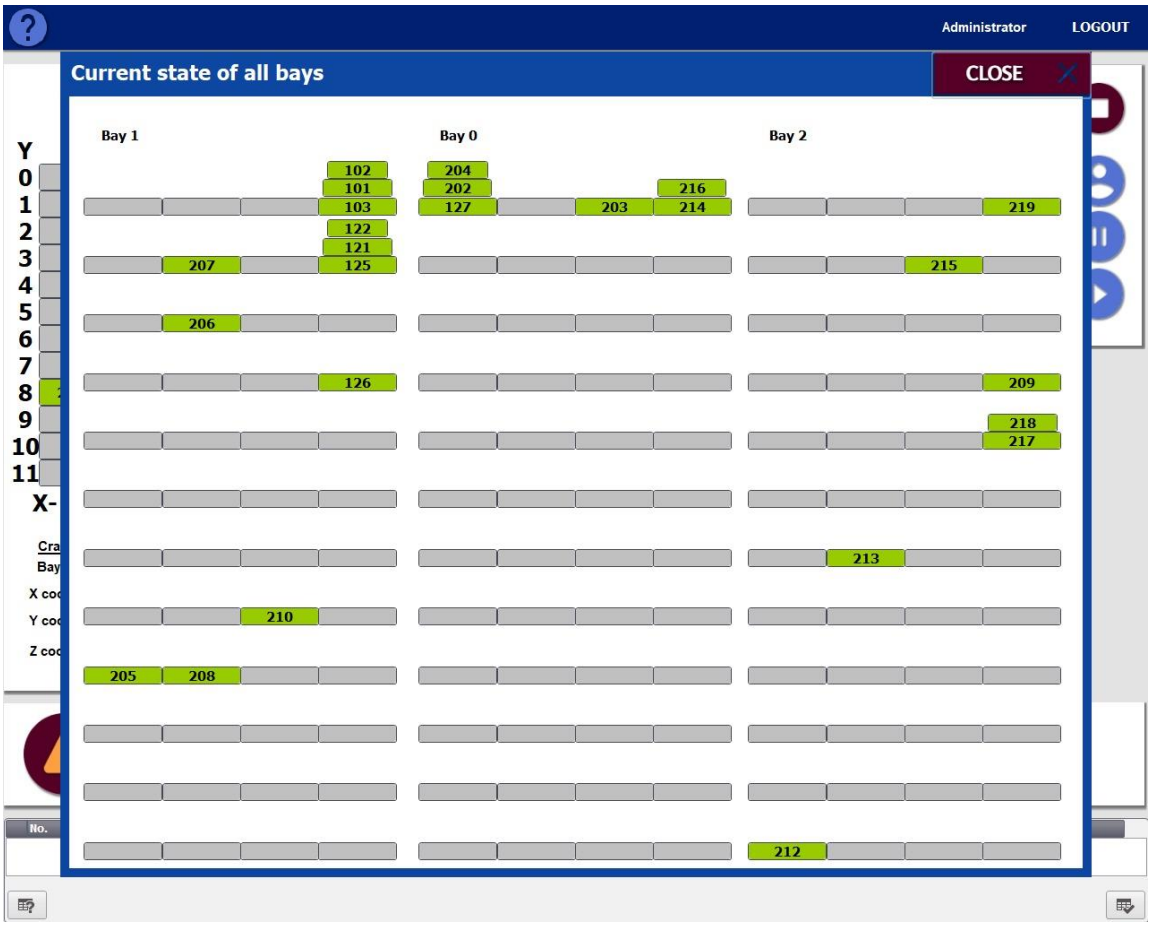

figure 4.4- Final current state of all bays

If you have any more questions, contact customer support or manufacturers of the used software. This program is tested with TIA portal version 15.1. and is functioning properly.

This program is not to be used for commercial purposes without the permission of its manufacturers, students Dominik Polić, Domagoj Jurendić and Filip Katulić.

This program can be used freely for educational purposes, but with with giving credits to the authors of this program solution, students Dominik Polić, Domagoj Jurendić and Filip Katulić.